

# Sensitivity analysis of climate change risk assessment

## Study of parameters variation in hazard indicators

Marco Casari

Supervisors

Prof.ssa Elisa Palazzi

Prof. Alberto Viglione

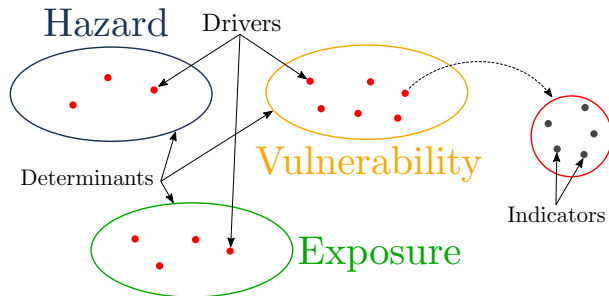
University of Turin

Midterm discussion, 4 July 2024

- ▶ Risk: potential for adverse consequences for human or ecological systems [...]

# Definitions

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- ▶ Climate Change Risk Assessment (CCRA)



# The problem

- ▶ The choice of indicators is arbitrary

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- ▶ The choice of indicators is arbitrary
- ▶ Analysis of the sensitivity of indicators to a change in value of their parameters, for **drivers** within the **hazard** determinant

## ► Torino Airport

# Case study

- ▶ Torino Airport
- ▶ Hazard drivers: heat wave, heavy precipitation

- ▶ Climatological baseline: ERA5<sup>1</sup>
- ▶ Climate projections: NEX-GDDP-CMIP6<sup>2</sup>

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<sup>1</sup>Hersbach et al., *ERA5 Hourly Data on Single Levels from 1940 to Present*.

<sup>2</sup>Thrasher, Wang, Michaelis, and Nemani, *NEX-GDDP-CMIP6*; Thrasher, Wang, Michaelis, Melton, et al., “NASA Global Daily Downscaled Projections, CMIP6”.



- ▶ Organisation: European Centre for Medium-Range Weather Forecasts
- ▶ Data type: reanalysis
- ▶ Spatial coverage: global
- ▶ Spatial resolution:  $0.25^\circ \times 0.25^\circ$
- ▶ Temporal coverage: 1940-present
- ▶ Temporal resolution: hour

- ▶ Organisation: NASA Earth Exchange
- ▶ Data type: statistically downscaled bias-corrected climate projections
- ▶ Spatial coverage: global
- ▶ Spatial resolution:  $0.25^{\circ} \times 0.25^{\circ}$
- ▶ Temporal coverage: 1950-2100
- ▶ Temporal resolution: day
- ▶ Historical period 1950-2014, projection period 2015-2100
- ▶ Model: EC-Earth3
- ▶ Scenario: SSP1-2.6, SSP2-4.5, SSP5-8.5

- ▶ Box of  $3 \times 3$  grid points centred at the coordinates of the airport

# Temporal domain

- ▶ Baseline period: 1994-2023
- ▶ Time horizons: 2021-2040, 2051-2070, 2081-2100

## 1. Select indicators:

- ▶ heat wave frequency (tasmin threshold, tasmax threshold, window size)
- ▶ maximum  $n$ -days precipitation amount (window size)

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  - ▶ heat wave frequency (tasmin threshold, tasmax threshold, window size)
  - ▶ maximum  $n$ -days precipitation amount (window size)
2. Fix exposure and vulnerability from literature
3. Evaluate risk following the guidelines

$$r = r(\mathcal{H}, \mathcal{E}, \mathcal{V}) = r(H, E, V) = \frac{w_H H + w_E E + w_V V}{w_H + w_E + w_V} = c_0 + c_1 H \quad (1)$$

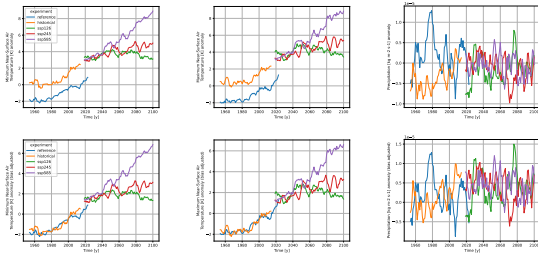
# Preprocessing

1. Regrid ERA5
2. Aggregate ERA5 at daily frequency
3. Align NEX-GDDP-CMIP6 timestamps



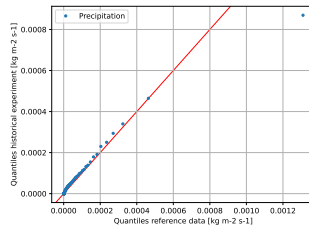
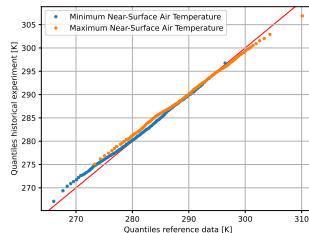
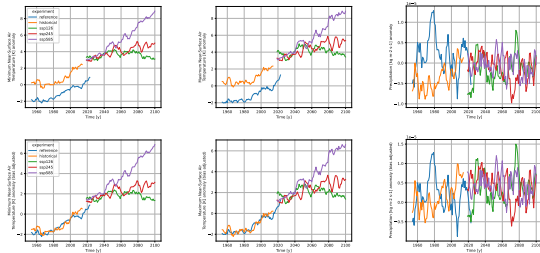
# Preprocessing

1. Regrid ERA5
2. Aggregate ERA5 at daily frequency
3. Align NEX-GDDP-CMIP6 timestamps
4. Bias adjustment



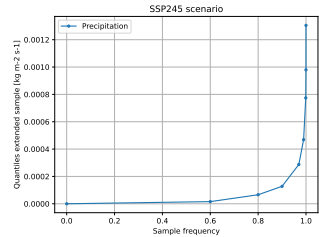
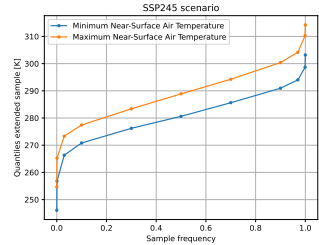
# Preprocessing

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# Evaluation of hazard indicators

## 1. Define intervals of parameter values



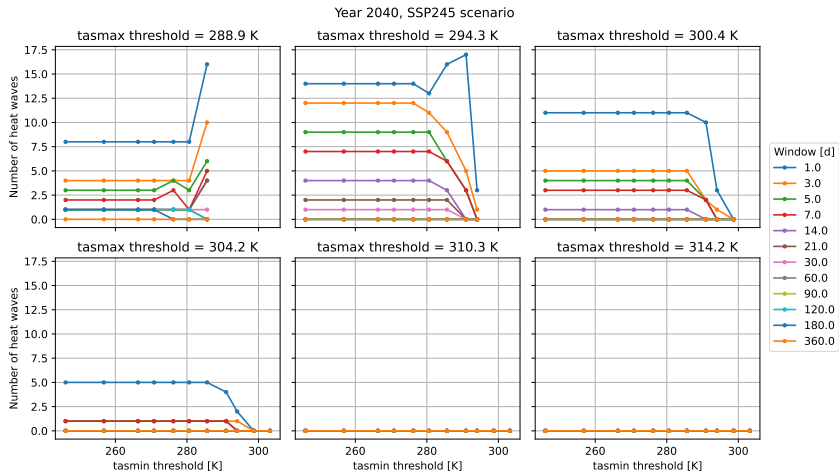
# Evaluation of hazard indicators

1. Define intervals of parameter values
2. Spatial aggregation

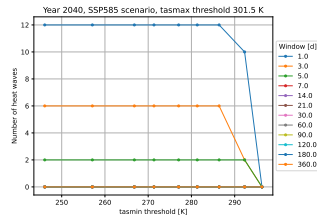
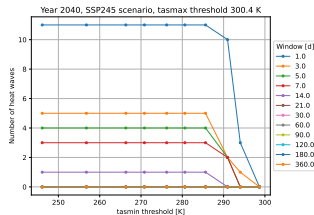
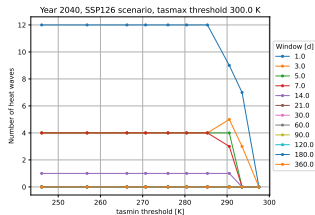
# Evaluation of hazard indicators

1. Define intervals of parameter values
2. Spatial aggregation
3. Temporal aggregation

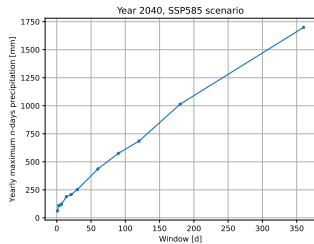
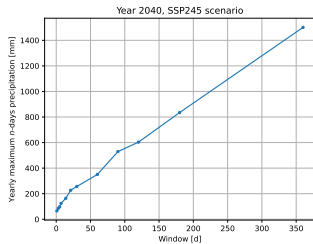
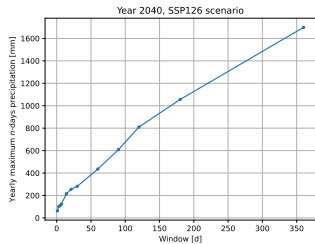
# Heat wave frequency – Fixed scenario



# Heat wave frequency – Fixed tasmax threshold



# Maximum $n$ -days precipitation amount





## Next steps

- ▶ Extend analysis to other indicators for each hazard drivers
- ▶ Extend analysis to Bologna's and Ciampino's airports
- ▶ Sample intervals specifically for the location of interest
- ▶ Normalise indicators
- ▶ Evaluate risk with non-linear relations among hazard indicators and among determinants
- ▶ Evaluate uncertainty (multi-model ensemble)